

# Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase I

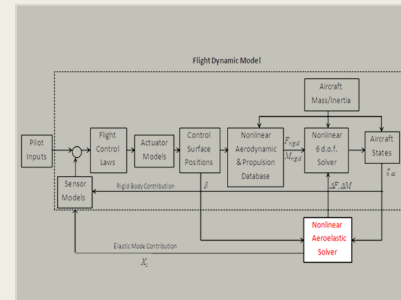
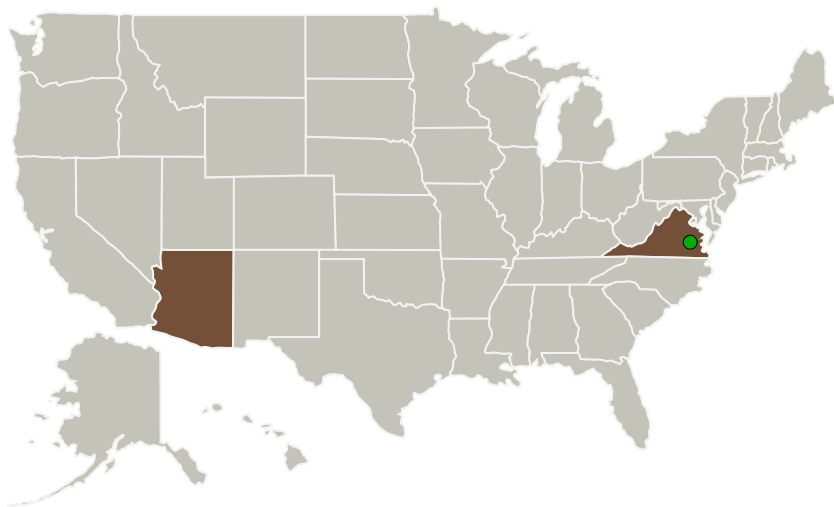
Completed Technology Project (2016 - 2016)



## Project Introduction

The overall technical objective of the Phase I effort is to develop a nonlinear aeroelastic solver utilizing the FUN3D generated nonlinear aerodynamic Reduced Order Model (ROM). Two types of aerodynamic reduced order models will be developed; the first is the Neural Network nonlinear ROM that can provide the aerodynamic feedback forces due to structural deformation and the second is a nonlinear Volterra-kernels-based gust ROM that provides the aerodynamic forces due to gust excitation. Once developed, this nonlinear aeroelastic solver will be integrated into the Nonlinear Dynamic Flight Simulation (NL-DFS) system in Phase II to perform flight dynamic simulation including nonlinear aeroelastic and nonlinear rigid body interaction effects, which can be used to predict the gust loads, ride quality, flight dynamic stability, and aero-structural control issues. In addition, the nonlinear aeroelastic solver developed can be a standalone code for rapid static/dynamic aeroelastic analysis. With the utilization of the FUN3D generated nonlinear aerodynamic (ROM), this nonlinear aeroelastic solver will be computational efficient for accurate flutter analysis, gust loads analysis and limit cycle oscillation analysis.

## Primary U.S. Work Locations and Key Partners



Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase I

## Table of Contents

Project Introduction	1
Primary U.S. Work Locations and Key Partners	1
Project Transitions	2
Images	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Technology Areas	3
Target Destinations	3

# Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase I

Completed Technology Project (2016 - 2016)



Organizations Performing Work	Role	Type	Location
ZONA Technology, Inc.	Lead Organization	Industry Small Disadvantaged Business (SDB)	Scottsdale, Arizona
● Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

## Primary U.S. Work Locations

Arizona	Virginia
---------	----------

## Project Transitions

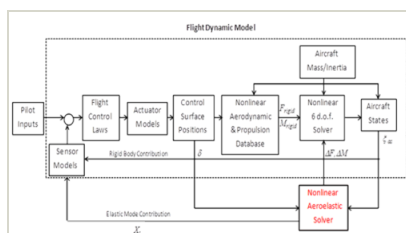
▶ **June 2016:** Project Start

✓ **December 2016:** Closed out

### Closeout Documentation:

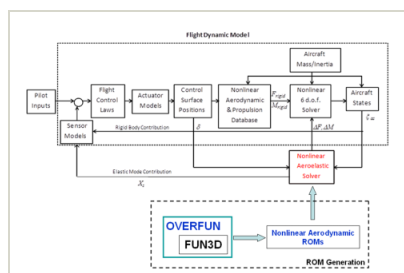
- Final Summary Chart(<https://techport.nasa.gov/file/139842>)

## Images



### Briefing Chart Image

Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase I  
(<https://techport.nasa.gov/image/134497>)



### Final Summary Chart Image

Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase I Project Image  
(<https://techport.nasa.gov/image/130703>)

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

ZONA Technology, Inc.

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

### Program Director:

Jason L Kessler

### Program Manager:

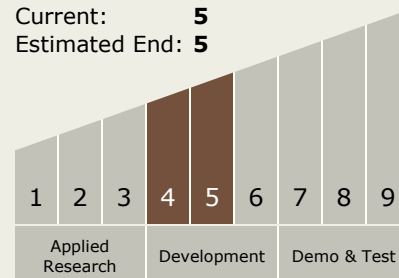
Carlos Torrez

### Principal Investigator:

Zhicun Wang

## Technology Maturity (TRL)

Start: 4  
Current: 5  
Estimated End: 5



# Dynamic Flight Simulation Utilizing High Fidelity CFD-Based Nonlinear Reduced Order Model, Phase I

Completed Technology Project (2016 - 2016)



## Technology Areas

### Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - └ TX11.1 Software Development, Engineering, and Integrity
    - └ TX11.1.7 Frameworks, Languages, Tools, and Standards

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System